PREFACE

Grape cultivation in India is more challenging due to changing climatic conditions and occurrence of several biotic and abiotic stresses. Moreover, the grape production is affected by various practices like application of plant growth regulators at specific concentration at specific growth stages. Canopy management plays an important role in overall development and growth of vine leading to the enhanced fruit yield and quality. Grape cultivation in problematic soil is more challenging therefore under such conditions, water and nutrient management is crucial. Every year grapes are affected by the major pests and diseases which are causing huge crop loss, therefore indiscriminate use of chemicals add to the cost of production which leads to the residue in the produce. Therefore, bio-intensive disease management strategies can be considered important in mitigating these challenges. This e-publication covers all the calendar of activities to be followed at different growth stages of grapevine under semi-arid conditions. This e-publication is a compilation of research work done during the last two decades at ICAR-National Research Centre for Grapes, Pune. This publication also provide the preventive measures to be taken up for efficient utilization of input and reduction in total cost of production. This e-publication will serve as a source of information and guideline for grape growers, State Govt. officers, researchers, students and other stakeholders in India. The schedule of cultural operations given in this publication can be modified depending upon situation of vineyards in a specific area and may vary under different climatic conditions, soil type and varieties.

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Director

Table: Calendar of activities for fruit pruning season based on different crop growth stages of grapevine

Days after pruning	**Crop stage**	**Disease / Pest / canopy / nutrient / water / PGR**	**Activity / Management strategy**	**Remarks**
Pre-pruning period	Two weeks before pruning	Defoliation	Foliar spray of ethephon @ 2 to 5 ml/L of water for leaf fall. The dose may vary from 3.0 to 5 ml/L water depending upon the foliage conditions.	For complete defoliation of leaf it will help to mobilize the food material from leaf to bud via petiole. The increase of ethylene and reduction in auxin in vine will help to bulge the buds and thus early and uniform bud sprouts will be achieved. 0:52:34 @ 5 g/L of water may also be added for effective results for effective defoliation, the vine should be water stress for atleast 5-6 days.
		Mealybug, ants, lepidopteran stem borer	Removal of loose bark and plant wash with *Metarhizium anisopliae* + *Lecanicillium lecanii* ($2x10^8$ spores per ml) @ 3.0+3.0 mL/L water (water volume 1.5 liter per vine).	• Preventive application to reduce the inoculum of mealybug, ants and lepidopteran stem borer

		Downy and powdery mildew, anthracnose inoculum	• Soil application/drenching of *Trichoderma* @ 2 L or kg/ acre or Manjari Trichoshakti @ 10 g/acre. • Spray *Trichoderma* @ 5 ml /Manjari Vineguard @ 2 ml/L to cover vines completely including main stem and cordons.	• For induced systematic resistance (ISR) & to reduce inoculum in soil • To reduce pathogen inoculum present in the vineyard
		Nutrition	• Soil and irrigation water testing	• This will help to understand soil and irrigation water quality. Soil sample should be obtained from 10-15 cm away from dripper and up to 1 feet depth. In uniform vineyard, 7-8 samples should be drawn and mixed properly. One kg soil should be given to Laboratory for testing. For irrigation water sampling, allow the pump to run for 30 minutes. After that water sample (1 litre) should be collected in clean glass bottle.
		Nutrition	• Apply FYM/Compost/Any other organic matter sources @ 10 tonnes/acre and sulphur/gypsum as per the need	Calcareous soil - apply sulphur Sodic soil - apply gypsum

				Sodic + calcareous apply sulphur
	1 week before pruning	Thrips, flea beetle, ants	• Soil drenching with *Metarhizium anisopliae* + *Beauveria bassiana* ($2x10^8$ spores/ml) @ 2 + 2 L/ha	Preventive application to reduce the inoculum of thrips, flea beetle and ants
		Downy and powdery mildew, anthracnose inoculum	• Spray *Trichoderma* @ 5 ml /Manjari Vineguard @ 2 ml/L to cover vines completely including main stem and cordons • Soil application/drenching of *Trichoderma* @ 2 L or kg/acre or Manjari Trichoshakti @ 10 g/acre.	• For induced systematic resistance (ISR) and to reduce inoculum in soil • To reduce pathogen inoculum present in the vineyard
	1-2 days before pruning	Downy and powdery mildew, anthracnose inoculum	Downy mildew infected leaves should be collected and destroyed.	• To minimize carry over inoculum
		Bud testing	Bud testing for fruitfulness. Five to six canes of different categories (6-8 mm, 8-10 mm and above 10 mm diameter each) to be selected randomly from one acre vineyard for bud testing under microscope.	Bud testing will help in locating fruitful bud position while pruning and avoid errors in deciding pruning position.
		Fruit Pruning	Under the condition of non-availability of bud	Fruit pruning

			testing results, prune the cane at one bud above the knot (sub-cane) while in case of straight cane prune above short internode which could probably come at 6-8 bud position.	
After Fruit Pruning				
1	Just After fruit pruning	Application of hydrogen Cyanamide.	Pasting up to 3 buds from top with Hydrogen cyanamide @ 30-50 ml/L. Concentration of Hydrogen cyanamide will vary between 30 to 50 ml / L depending upon the cane diameter, bud swelling and the temperature during the pruning time. Higher concentration may be needed for canes with larger diameter, while, lower dose may be needed when buds have already swollen.	• Application of hydrogen cyanamide is for easy and uniform bud break.
1-2	Dormant buds	Mealybug	• Removal of loose bark and plant wash with buprofezin 25 SC @ 1.25 ml/L + *Metarhizium anisopliae* ($2x10^8$ spores per ml) @ 3.00 ml/L water (water volume 1.5 liter per vine)	• Preventive application to check spread of mealybug on new growth
		Thrips, flea beetle, ants	• Soil drenching with *Metarhizium anisopliae* + *Beauveria bassiana* ($2x10^8$ spores per ml) @ 2 + 2 L per hectare	• Preventive application to reduce the inoculum of thrips, flea beetle and ants

		Downy and powdery mildew, anthracnose	• Diseased canes and dead wood should be removed. • Drenching of cordon with Mancozeb 75 WP @ 2.5 g/L and sulphur 80 WG @ 2.0 g/L once. • Mix mancozeb 75 WP (5 g / L) with Hydrogen Cynamide (30-40 ml/L) paste for cane swabbing. • If the un-pruned block is in close vicinity of pruned block, and the pruning in that block is not likely to take place within 5- 8 days, it will be essential to spray *Trichoderma* in un-pruned block.	• Addition of Mancozeb with Hydrogen Cyanamide as a preventive measure which help in killing pathogen inoculum if present on canes. • To avoid dispersal/spread of downy mildew infection in pruned vines.
4-5	Dormant to swollen bud	Downy mildew and powdery mildew	• Soil application of *Trichoderma* @ 2 L/acre or 2 kg/acre or Manjari Trichoshakti @ 10 g/acre. Application of copper hydroxide @ 1.5-2 g/L	For development of Induced Systemic Resistance (ISR) in plants. Preventive measure and to reduce pathogen inoculum present in soil.
8-10	Initiation of sprouting	Nutrition	Apply nitrogenous fertilizer @ 32 kg /acre This could be in the form of urea/ ammonium sulphate and will continue from 9 to 30 days. This is required for active vegetative phase.	Application will depend upon the soil related issues. Always apply in splits to avoid wastage of nutrients. Regulate nitrogenous fertilizer

				application based upon the vigour of the vine.
		Flea beetle, Mealybug, Leafhoppers and Thrips	• Imidacloprid 17.8 SL @ 0.4 ml/L water (water volume 750 L/Ha)	• Preventive measure
		Anthracnose	Carbendazim 50 WP @ 1.0 g/L or Thiophanate methyl 70 WP @ 0.75 g/L or Kasugamycin 5% + Copper Oxychloride 45% WP @ 750 g/ha	In the event of rains to protect young growing tips
		Downy mildew and bacterial spot	Spraying of mancozeb 75 WP @ 2 g /L or Kasugamycin 5% + Copper Oxychloride 45% WP @ 750 g/ha Dusting of mancozeb 75 WP @ 3 kg/acre	Preventive application If the conditions are wet (rains or heavy dew)
11-15	At three leaf stage	Downy mildew and powdery mildew	• Soil application of *Trichoderma* @ 2 L or kg/acre. Manjari Trichoshakti @ 10 g/acre.	For development of Induced Systemic Resistance (ISR) in plants and to reduce pathogen inoculum in soil
		Downy mildew	Spray any of CAA fungicide formulations-(Iprovalicarb 5.5 + Propineb +61.25)-66.75WP @ 2.25 g/L or Mandipropamid 23.4% SC @ 0.8ml/L or (Ametoctradin 27 + Dimethomorph 20.27)-47.27 SC @ 0.8-	Preventive measure

			1ml/L or Dimethomorph 50 WP @ 1.0 g/L + Mancozeb 75 WP @ 2.0 g/L as tank mix. Spray Amisulbrom 17.7% SC @ 375 ml/hectare	
			Fosetyl-Al 80WP@ 4 g/L or Potassium salt of phosphorus acid @ 4 g/L as a tank mix with Mancozeb 75WP @ 2g/L or Metiram 70WG@ 2g/L can be preferred if weather conditions are wet because these are better systemic fungicides under wet conditions.	Preventive and curative measures
15 to 35	14-17 Bud emergence stage	Canopy management	Based upon the bunch requirement for export/ local/ raisin, shoot as well as bunch retention to be followed.	This will also help to reduce the incidence of flower necrosis and to retain the optimum shoots. Removal of excess shoot immediately after the bunch emergence will help for aeration in the small canopy thereby reducing the chances of inflorescence rot, It will also support for complete coverage of fungicide/PGR sprays during pre-bloom stage.

	17-20	PGR application	Spray GA_3 @ 10 ppm. This stage generally comes between 17 to 20 days depending upon weather conditions and soil type. pH of the spray solution should be maintained at 5.5 to 6.0. To maintain pH of spray solution, citric acid/ urea phosphate can be added. This will help to increase rachis length.	Increase in rachis length and distance between two rachis to obtain loose bunch.
			Second GA_3 spray @ 15 ppm (5 days after 1st spray)	Rachis elongation and to obtain loose bunch
	15-26	Nutrient management	Foliar spray Zinc Sulphate @ 2g/L and Boric acid @ 2 g/L. To buildup zinc and boron levels in vines for berry setting	To meet nutrient requirement during active vegetative growth stage.
			Apply Magnesium Sulphate @ 15 kg/acre + Zinc Sulphate @ 20 kg/acre + Ferrous Sulphate @ 20 kg/acre and Boric acid @ 1-2 kg/acre. This will continue from 14 to 25 days. Always apply in 2-3 splits to avoid wastage of nutrients. If leaves / bunches show yellowing, check for soil calcium carbonate / sodium/ salinity content. In case any issue immediately go for desired reclamation measures.	To meet nutrient requirement during active vegetative growth stage.
	25-30	Canopy	Removal of excess bunches from the vine.	This will help in proper

		Management	Bunch retention should be based upon the purpose i.e. for export: 1 bunch/1.5 sq. ft.; local: 0.75 bunch/sq. ft. ; raisin: 1.5 to 2.0 bunches/ sq. ft. Retention of bunches can be based on cane diameter i.e. < 6 mm cane: one bunch with one supporting shoot. And 8-10 mm cane: two bunches / shoot and one supporting shoot. To maintain source: sink ratio: for proper bunch development allow 10-12 leaves to grow above bunch. The leaf size should be 160-170 sq. cm. since each leaf help in developing 6-8 berries.	utilization of food material available and improve berry size required. Retention of bunches based on cane diameter will help to utilize reserve food material and maintain the balance between source and sink. Leaf plays an important role in bunch development through photosynthesis. Maintaining healthy leaf will also be necessary.
	Early shoot growth stage to flowering	Mealybug, Thrips and Leafhoppers	• *Metarhizium anisopliae* + *Lecanicillium lecanii* ($2x10^8$ spores/ml) @ 3.0+3.0 ml/L water (water volume 1.5 liter per vine) at 30 days after pruning.	• Preventive application when maximum temperature is less than 30 degree Celsius and average relative humidity is more than 60 %.
		Leafhoppers	• Install light traps at the rate one per acre and run for three hours (7.30 p.m. to 10.30 p.m.) daily up to 12 mm berry size stage.	• Preventive measure
		Thrips and leafhoppers	• Fipronil 80 WG @ 0.06 or emamectin benzoate 5 SG @ 0.22 g/L water	• 2 thrips or/& leafhoppers per shoot. Thrips population should

				be monitored during afternoon hours by tapping the vine shoots on white paper. Jassid population should be observed during early morning / evening hours by gently holding the shoots.
		Caterpillar (*Spodoptera litura*)	• Spraying of *Sl*NPV @ 250 LE/hectare or *Bacillus thuringiensis* ($1x10^{11}$ viable spore count/gram) @ 5 g/L water or emamectin benzoate 5 SG @ 0.22 g/L water	• Sightings of egg mass, caterpillars or damaged leaves on observed vines
		Mealybugs	• Imidacloprid 17.8 SL @ 0.4 ml/L water foliar spray • Tagging of mealybug infested plants and removal of loose bark and plant wash of infested plants with buprofezin 25 SC @ 1.25 ml/L (water volume 1.5 liter per vine) at 20 and 30 days after pruning.	• Sightings of shoot malformation
		Downy mildew	Spray any of CAA fungicide formulations-(Iprovalicarb 5.5 + Propineb +61.25)-66.75WP @ 2.25 g/L or Mandipropamid 23.4% SC @ 0.8ml/L or (Ametoctradin 27 + Dimethomorph 20.27)-47.27 SC @ 0.8-	Preventive based on weather risk

			1ml/L or Dimethomorph 50 WP @ 1.0 g/L + Mancozeb 75 WP @ 2.0 g/L as tank mix. or (Cymoxanil 8+Mancozeb 64)-72 WP @2g/L Spray Amisulbrom 17.7% SC @ 375ml/ha	
			Total number of sprays of CAA based fungicides should not exceed three in a season. Spray of Amisulbrom should not be more than two in the season. Applications of these fungicides should be taken up before and after the rainy spell when the humidity is relatively low and should be avoided in high humidity conditions during the rainy spell. Fosetyl-Al 80WP @ 4 g/L or Potassium salt of phosphorus acid @ 4 g/L as a tank mix with mancozeb 75WP @ 2g/L or metiram 70WG @ 2g/L can be preferred if weather conditions are wet because these are better Systemic fungicides under wet conditions.	Preventive based on weather risk
			If wet conditions continue for more than three days continuously, use of non- systemic fungicides such as dithiocarbamates e.g. metiram 70WG @ 2 g/L, should be preferred for spray in place of CAA fungicides or	Wet conditions for more than three days will lead to sporulation and initiate secondary infection.

			cymoxanil to avoid sporulation and secondary infection. It is very critical to repeat CAA systemic fungicide applications after rainy spell stops.	
			Fungicides may get washed off during long rainy spell, use of bio-agents such as *Trichoderma* or *Bacillus* will help in reducing disease incidences.	To reduce pathogen inoculum
			• Soil application of *Trichoderma* @ 2 L or kg / acre or Manjari Trichoshakti @ 10 g/acre.	For development of induced systemic resistance can be applied through drip Irrigation system.
		Anthracnose	Dithiocarbamate fungicides used for downy mildew control will be effective for anthracnose control and no separate application may be required. In case of incidence, application of difenoconazole 25EC@ 0.5ml/L should be given which will also help in reducing shoot vigour and reduce downy mildew risk. Kasugamycin 5% + Copper Oxychloride 45% WP @ 750g/ha may also be applied to reduce recurrent infection.	Preventive and need-based

		Powdery mildew	Spray Cyflufenamid 5% EW @ 500ml/ha or Hexaconazole 5EC @ 1 ml/L or difenoconazole 25 EC @ 0.5 ml/L or (Fluopyram 200+Tebuconazole 200)- 400SC @ 0.5 ml/L or Tetraconazole 3.8EW @ 0.75 ml/L	Fungicide coverage to the inner canopy is very essential for powdery mildew management and this is the correct stage to ensure that inner canopy is covered.
		Downy and Powdery mildew or Anthracnose	Spray *Bacillus subtilis* 2.0 ml or g /L or *Trichoderma* sp. 5 ml or g /L or Manjari Vineguard @ 2 ml/L	For
		Nutrition	Foliar spray of of calcium (Calcium chloride @ 2g/L water). There are other sources of calcium for foliar application. Check the individual recommendation and accordingly apply. In case of possibility of weather forecast for rains, apply 15 kg SOP/ acre in splits through drip and provide foliar spray of SOP @ 3g/L.	To increase calcium uptake in vines. To increase potassium levels in vine.
36 to 50 days after pruning	flowering and berry setting	PGR applications (Elongated berries)	25% flowering: GA_3 spray @15ppm	To form elongated berries (capsule)
			50 % Flowering: GA_3 @ 20 ppm	
			90 % Flowering: GA_3 @ 20 ppm	
			pH of the spray solution should be maintained	

			at 5.5 to 6. To maintain pH of the spray solution, citric acid/ urea phosphate can be added.	
		PGR applications for flower thinning	@ 50% Flowering: GA_3 @ 40 ppm. pH of the spray solution should be maintained at 5.5 to 6. To maintain pH of the spray solution, Phosphoric acid can be added. This will help to reduce berry setting and increase the rachis length.	Pollenicidal action to reduce setting.
	2/3rd Cap fall stage	Petiole analysis	Petiole sampling; Purpose: Required for vineyard nutrient management	Petiole sampling – collect leaves opposite the bunch for sampling and submit to laboratory for analysis.
		Canopy management	Shoot tipping to stop shoot growth after berry setting; It will help in maintaining open canopy which will help to build up humidity thereby reducing chances of bunch necrosis. It will also help in reducing thrips population build up.	To control shoot vigour and regulate canopy such that atleast 30% sunlight falls on the ground.

		Nutrient management	Apply phosphorus @ 20 kg P_2O_5/ acre; Always apply in 2-3 splits to avoid wastage of nutrients. It can be applied in the form of Single Super Phosphate/ phosphoric acid/ Monoammonium phosphate/ DAP. In case of vigorous vineyards do not apply N based phosphatic fertilizers.	To meet phosphorus requirement
	Flowering and berry setting	Thrips	• Cyantraniliprole 10 OD @ 0.7 mL/L or Emamectin benzoate 5 SG @ 0.22 g/L or Spinosad 45 SC @ 0.25 ml/liter: At pre-bloom stage • Spinosad 45 SC @ 0.25 ml/liter or Emamectin benzoate 5 SG @ 0.22 g/L or Cyantraniliprole 10 OD @ 0.7 ml/L or Spinetoram 11.7 SC @ 0.3 ml/L water: At initiation of berry setting • Shoot tipping to stop shoot growth after berry setting is complete.	• Preventive and more sprays if thrips more than 2 thrips per inflorescence • Preventive measure
		Leafhoppers	• Emamectin benzoate 5 SG @ 0.22 g/L or Lambda cyhalothrin 5 CS @ 0.5 ml/L water	• 2 leafhoppers per shoot
		Caterpillars	• Spraying of *Sl*NPV @ 250 L/hectare or *Bacillus thuringiensis* ($1x10^{11}$ viable spore count/gram) @ 5 g/L water or emamectin benzoate 5 SG @ 0.22 g/L water	• Sightings of egg mass or caterpillars on observed vines

		Mealybugs	• Tagging of mealybug infested plants and removal of loose bark and plant wash of infested plants with buprofezin 25 SC @ 1.25 ml/L (water volume 1.5 liter per vine) at 40 and 50 days after pruning.	• Sightings of mealybug
		Powdery mildew	Spray Cyflufenamid 5% EW @ 500 ml/ha or Hexaconazole 5EC @ 1 ml/L or difenoconazole 25EC @ 0.5ml/L or (Fluopyram 200+Tebuconazole 200)- 400SC @ 0.5 ml/L or Myclobutanil 10 WP @ 0.4 g/L or Tetraconazole 3.8EW @ 0.75 ml/L or (Pyraclostrobin 25+Fluxapyroxad 25)-50SC @ 0.2 ml/L or Metrafenone 50SC @ 0.25 ml/L	Preventive measure
		Downy mildew	Spray Fosetyl AL 80 WP @ 3.0 g/L or Potassium salt of phosphorus acid @ 4 g/L+ metiram 70WG @ 2 g/L	Preventive measure
			In the event of possibility of heavy rains and dew, application of spray oil (mineral oil) will help in reducing the retention of water in cluster at flowering stage.	Water accumulation might lead to 100% crop loss.

			Application of mono potassium phosphate or SOP 2-3 g/L is known to help in reducing vigour as well as development of downy and powdery mildews. Curling due to Potassium deficiency reduces coverage of fungicides and provides favourable micro-climate for powdery mildew development.	To reduce plant vigour and control downy mildew infection.
		Downy, powdery mildew and anthracnose	Spray *Bacillus subtilis* 2.0 ml or g /L or *Trichoderma* sp. 5 ml or g /L or Manjari Vineguard @ 2 ml/L	For development of induced systemic resistance and reduce pathogen inoculum present on vines.
50-60 days after pruning	Berry development	PGR application for round/oblong berries	3-4 mm berry size: GA_3 @ 40-50 ppm + CPPU @ 1-2 ppm	To increase the berry size
			7-8 mm berry size: GA_3 @ 30-40 ppm + CPPU @ 1-2 ppm. pH of the spray solution should be maintained at 5.5 to 6. To maintain pH of the spray solution, Phosphoric acid can be added. This will help to increase berry size. Lower doses of CPPU may be used for elongated berries. If spraying is carried out with ESS, no need of pH adjustment.	
		Nutrient	**2-8 mm berry size:** Two to three foliar sprays	Effective absorption of calcium

		Management	of calcium (Calcium chloride @ 2g/L water). There are other sources of calcium for foliar application. Check the individual recommendation and accordingly apply Purpose: For efficient calcium absorption in the berries.	as the berry skin is elastic. This is especially useful during the GA3 application stage. This could also aid in managing powdery mildew infection and make the berry skin strong to withstand berry cracking conditions.
			After berry setting to 10 mm berry size: Apply phosphorus @ 20 kg P_2O_5/acre and magnesium sulphate @ 15 kg/acre; Purpose: To meet phosphorus and magnesium requirement	Always apply in 2-3 splits to avoid wastage of nutrients. P can be applied in the form of Single Super Phosphate/ phosphoric acid/ Monoammonium phosphate/ DAP.
		Thrips	• Emamectin benzoate 5 SG @ 0.22 g/L water: 2-4 mm berry size. • Spinosad 45 SC @ 0.25 ml/L or Spinetoram 11.7 SC @ 0.3 mL/L water: 6-8 mm berry size	• Preventive and more sprays if thrips more than 2 thrips per bunch
		Thrips and Leafhoppers	• Emamectin benzoate 5 SG @ 0.22 g/L water	• 2 thrips per bunch; 3 leafhoppers per shoot
		Caterpillars	• Spraying of *Sl*NPV @ 250 LE/hectare or *Bacillus thuringiensis* ($1x10^{11}$ viable spore	• Sightings of egg mass or caterpillars on observed vines

			count/gram) @ 5 g/L water or emamectin benzoate 5 SG @ 0.22 g/L water	
		Mealybugs	• Soil drenching with clothianidin 50 WDG @ 0.275 g/vine • Two plant washes with buprofezin 25 SC @ 1.25 ml/L at 10 days interval just before veraison stage (water volume 1.5 liter per vine) PHI 65 days	• Preventive measure
		Mites	• Foliar spray of *Hirsutella thompsonii* ($2x10^8$ cfu per ml) @ 3 ml/L water at 60 days after pruning • Sulphur 80 WG @ 2.0 g/L or Abamectin 1.9% EC @ 0.75 mL/L or Bifenazate 22.6% SC @ 0.5 mL/L water (water volume 1000 L/Ha)	• Preventive measure • Sightings of web formation at underside of leaves
		Powdery mildew	Spray Meptyldinocap 35.7% EC @0.3-0.35ml/L Spray Chitosan @ 2g/L	Spray of meptyldinocap should be avoided earlier than this period as it may cause phytotoxicity on young leaves. It should also be avoided after this period as it may lead to residues.
			Spray *Ampelomyces quisqualis* 3 to 4 g/L or *Bacillus subtilis* 2.0 ml or g /L or *Trichoderma* sp. 5 ml or g /L or Manjari	For development of induced systemic resistance and reduce pathogen inoculum present on

			Vineguard @ 2 ml/L If minimum temperature is above 10^{o}C and RH is more than 60 per cent.	vines
		Nutrient Management	**10 mm berry size till veraison initiation:** Apply nitrogenous fertilizer @32 kg /acre Purpose: This is required during berry growth stage to increase berry size.	This could be in the form of urea/ ammonium sulphate and will continue till veraison initiation. Application will depend upon the soil related issues. Always apply in splits to avoid wastage of nutrients.
			From 12 mm berry size till veraison: Apply potassium (K_2O) @ 32 kg/acre and magnesium sulphate @ 15 kg/acre Purpose: This is required during berry growth stage.	Always apply in splits to avoid wastage of nutrients. Sulphate of potash should be applied. Donot apply Muriate of potash as this will lead to build up of chlorides in the vines.
	Veraison stage	Mealybugs	• Spirotetramat 15.31% @ 280 ml/acre (PHI 60 days)	• Sightings of mealybug on bunches
		Mites	• Washing of leaves with 2500 liters water per hectare at weekly interval.	• Preventive measure • Preventive measure

			• Foliar spray of *Hirsutella thompsonii* ($2x10^8$ cfu per ml) @ 3 ml/L water at 75 and 90 days after pruning. • Sulphur 80 WG @ 2.0 g/L or Abamectin 1.9% EC @ 0.75 ml/L or Bifenazate 22.6% SC @ 0.5 ml/L water (water volume 1000 L/Ha) PHI 30 days.	• Sightings of web formation at underside of leaves and presence of live mites in more than 2 per cent leaves
		Thrips	• Spinetoram11.7% SC @ 0.3 ml/L (PHI 10 days) or Spinosad 45 SC @ 0.25 ml/L (PHI 15 days) or emamectin benzoate 5 SG @ 0.22 g/L water (PHI 25 days)	• 3 thrips per shoot or bunch
		Caterpillars	• Spraying of *Sl*NPV @ 250 LE/hectare or *Bacillus thuringiensis* ($1x10^{11}$ viable spore count/gram) @ 5 g/L or emamectin benzoate 5 SG @ 0.22 g/L water	• Sightings of egg mass or caterpillars on observed vines
		Powdery mildew	Spray sulphur 80 WG @ 2.0 g/L or or Metrafenone 50SC @ 0.25 ml/L. Use of *Bacillus* alternatively with fungicides. *Bacillus* and *Ampelomyces* are compatible with (Fluopyram 200+Tebuconazole 200)-400SC and may be used in alternation with fungicides at 7-10 days interval. Single application of chitosan @ 2 ml/L may	Use the fungicides based on PHI mentioned in Annexure V of RMP Avoid berry cracking

			be given if there is a light rain.	
			• Soil application of *Trichoderma* @ 2 L or kg / acre or or Manjari Trichoshakti @ 10 g/acre or *Bacillus* @ 1 L or kg / acre.	For development of Induced systemic resistance and to reduce pathogen inoculum present in soil.
		Canopy management	Covering of bunches with paper is applicable for exportable grapes.	To reduce pink berry incidence, use of shade net on canopy or brought bunches to be under canopy to avoid direct exposure to sunlight.
		Nutrient Management	Apply potassium (K_2O) @ 32 kg/acre and Magnesium Sulphate @ 15 kg/acre. This is required during ripening stage.	Always apply in splits to avoid wastage of nutrients. Sulphate of potash should be applied. Donot apply Muriate of potash as this will lead to build up of chlorides in the vines.
90 days after fruit pruning	Post veraison up to harvesting	Mites	• Washing of leaves with 2500 liters water per hectare at weekly interval. • Sulphur 80 WG @ 2.0 g/L or Abamectin 1.9% EC @ 0.75 ml/L or Bifenazate 22.6% SC @ 0.5 mL/L water (water volume 1000 L/Ha) PHI 30 days	• Preventive measure • Sightings of web formation at underside of leaves and presence of live mites in more than 2 per cent leaves

		Mealybugs	• Spot plant wash with trisiloxane polyether-based surfactants @ 0.3 ml/L water (water volume 10-12 L/plant) followed by wash with water on only mealybug infested plants.	• Sightings of mealybug
		Mites	• Sulphur 80 WG @ 2.0 g/L or Abamectin 1.9% EC @ 0.75 ml/L or Bifenazate 22.6% SC @ 0.5 mL/L water (water volume 1000 L/Ha) PHI 30 days.	• Sightings of live mites in more than 2 per cent leaves
		Thrips	• Spinetoram11.7% SC @ 0.3 ml/L (PHI 10 days) or Spinosad 45 SC @ 0.25 ml/liter (PHI 15 days) or emamectin benzoate 5 SG @ 0.22 g/L water (PHI 25 days).	• 3 thrips per shoot or bunch
		Postharvest disease	Spray *Trichoderma* sp. 5 ml or g /L or Manjari Vineguard @ 2 ml/L.	To control powdery mildew and may help to enhance degradation of pesticide residues
		Powdery mildew	Sulphur 80 WG @ 2.0 g/L water; or Spray *Bacillus subtilis* 2.0 ml or g /L	*Bacillus* will help in biodegradation of surface residues of pesticides
			Low residue risk options such as silver complex of Hydrogen peroxide or chlorine di-oxide may be used if the active growth of	It will kill the biocontrol agents also.

			powdery mildew is noticed.	
	20 days before harvest	Postharvest disease	Spray *Trichoderma* sp. 5 ml or g /L or Manjari Vineguard @ 2 ml/L.	To control powdery mildew, post-harvest decay, and may help to enhance degradation of pesticide residues.
	12 days before harvest	PGR application	NAA @ 50 ppm. To be used only when berry drop is observed.	To reduce berry drop particularly in raisin grapes.
	10 days before harvest	PM / Postharvest decay/pesticide residues	Spray *Bacillus subtilis* 2.0 ml or g /L or *Trichoderma* sp. 5 ml or g /L or Manjari Vineguard @ 2 ml/L	To control powdery mildew, post-harvest decay, and may help to enhance degradation of pesticide residues

Disclaimer: 1: All the doses mentioned above are for high volume sprayers, where normal spray volume is 1000 L/ha. Spray volume can however be changed as per the efficiency of sprayers used. However, the amount of each pesticide based on its active ingredient recommended for 1 ha area on the basis of 1000 L spray solution should be strictly maintained to ensure bio-efficacy and to minimize pesticide residues. 2: Recommended PHI will be valid only if two applications of an agrochemical are given per fruiting season at the interval of 7-15 days at recommended dose except in case of special mention in table. 3: If any of the pesticide found ineffective in controlling the targeted diseases or pests, it is advised not to give repeated applications of the formulation since it may lead to residue issues and increase the resistance population of targeted pathogen or insects. 4: The information provided in this document is of advisory nature. The responsibility of usage of chemicals for the management of any of the above pests and diseases and compliance of the produce to the EU-MRL requirement will rest with the growers. 5: Since risk of more than one pest may overlap, if appropriate insecticide is used, control of non-targeted pest can be achieved. Compliance for dose, number of applications and PHI as recommended for target pest is essential and should be strictly adhered. 6: Grapes being grown for export must follow only Annexure 5 of Residue Monitoring Programme. 7: This schedule may vary from activity to activity and situation of the vineyard.

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